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THE SCIENCE AND ART OF TRAINING: A REVIEW OF PRYOR'S LADS BEFORE THE WIND[1]

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In 1975 Karen Pryor published *Lads Before the Wind,* which now has been reprinted; it describes her experiences and observations as a porpoise trainer. The book begins with a noteworthy introduction by Konrad Lorenz; his expressed appreciation of contemporary behaviorism and its "wonderfully subtle methods" may surprise those familiar only with Lorenz's early writings. In addition, Lorenz described Pryor as "an ethologist who uses all the subtlety of conditioning . . . as a tool to gain knowledge about the animal as a whole" (p. viii), and hoped that her book will be used "as a textbook on animal learning in general, and Skinnerian conditioning in particular. . . . Her observations prove to the hilt that the stories about the almost superhuman mental faculties of porpoises . . . all are pure inventions, or, at best, self-deceptions of uncritical observers. . . . It is clear that this book is of the highest scientific significance" (p. ix).

Indeed, Pryor is a master animal trainer who has adopted operant techniques with rare skill. She also is an astute observer who is ready to learn from her trainees during their training, and an effective writer who adroitly engages both specialized and general audiences. Her book portrays some of this while describing the shaping and maintenance of complex and spectacular performances of porpoises and false killer whales (and a few other species) at the oceanarium, Sea Life Park. This beautiful show park was constructed in Oahu, Hawaii, through the efforts of Pryor and her (then) husband Tap Pryor in 1965. Before undertaking the post of chief trainer, Pryor's only explicit experiences in training had been with a pony and a dog. She took on the task when their project had reached an impasse: "Advance tickets were being sold. And there was no porpoise show. The porpoises, in fact, had trained their trainers to give them fish for nothing" (p. 4). Thus begins the engaging tale of a part-time commitment that became a full-time career.

In her work with porpoises, Pryor used a training manual written by Ron Turner, research affiliate at Sea Life Park and research associate of Kenneth Norris, the noted expert on cetaceans and director of the nearby Oceanic Institute. (Sea Life Park was established mainly to support the Institute and its programs of basic research, for Tap Pryor was a marine biologist.) I gained a first-hand acquaintance with the Pryors' work when spending 18 months at Oceanic Institute during 1968–1970, where Reed College maintained an operant conditioning laboratory through the generosity of the Institute. Along with my colleague Bill Wiest, I trained fish and undergraduates. We came to know the Pryors and most of the trainers and staff, as well as some resident and visiting scientists and scholars. I often attended the shows, and never failed to be struck by the remarkable performances of the cetaceans and other animals.

In those days, at least, Pryor regarded herself as a disciple of Lorenz, accepting his belief that in animals, "even communication behavior is usually inherited, innate rather than learned" (Pryor, p. 153).[2] In characterizing her own position, she expresses caution about reading human thoughts into animal reactions, while also avoiding "what Joseph Wood Krutch (1954) called 'mechanomorphism,' ruthlessly reducing all the animals' behavior to that of a machine-like automaton, counting for nothing if it cannot be measured, a ham-

[1] Pryor, K. (1991). *Lads before the wind* (2nd ed.). North Bend, WA: Sunshine Books.

Allen Neuringer made very helpful suggestions. Reprints can be obtained from the author at the Department of Psychology, Reed College, Portland, Oregon 97202.

[2] Lorenz (1991) held that operant conditioning is "experimentation with various motor patterns and the learning of the skills that lead to a certain goal." Greylag geese "learn an enormous amount, but they do not learn new motor skills. . . . Voluntary movement, the basic element through which higher vertebrates produce motor skills, is apparently not present in birds" (pp. 90–91).

pering but definitely fashionable error" (Pryor, p. 172). It is hard to imagine a trainer engaged with any behavior that cannot be measured, especially in the simplest form of being present or absent, so Krutch's term smacks of humanist cliché. On the other hand, the statement can be understood as protesting the same aspects of methodological behaviorism that B. F. Skinner (1945) rejected when introducing his radical behaviorist account of private events.

Karen Pryor was personally acquainted with Skinner, having met him and his daughter, Debby, when visiting Boston in 1966. (Debby later became "an imaginative trainer" for Pryor: "She was a dream, and we had fun together.") Skinner visited Sea Life Park and tried his hand at training a porpoise; he also enjoyed participating in a session of the Training Game (discussed below). He and Pryor remained in touch thereafter, but despite the exposure to Skinner in person as well as to his continuing output of papers and books, Pryor appears at that time not to have understood his orientation fully, as revealed by lines quoted from her journal of 1965: "Why does Skinner reject all that is sensible in ethology, while Gregory [Bateson] and other ethologists reject all that is sensible in operant conditioning?" (p. 168).[3] "Skinner is all very well, but if you can't tell when your animal is thinking hard, you'll never make it" (p. 111).

Other luminaries of behavioral science also were attracted to Sea Life Park. Pryor entertained John Lilly there, and was familiar with his book, *Man and Dolphin,* as well as with his scientific papers on porpoises; she comments that Lilly greatly overestimated the communication abilities of porpoises, "But John's ideas, though they smacked to me of mysticism, were often provocative" (p. 154). John Lilly urged the Pryors to provide space for Gregory Bateson and his then-ongoing project of observing the interactions of porpoises. Bateson subsequently spent 8 years at Oceanic Institute, the research arm of Sea Life Park, as "resident guru" (p. 156). He had "always despised Skinnerian theory and operant conditioning with an almost religious intensity," Pryor reports. "The fact that [it] works makes it even more infuriating to him. I always found Gregory's stand unbecoming to the scientist in him, but perfectly acceptable to the philosopher, who may hate that the sky is blue, if he wishes" (p. 160). Bateson rejected "all that is sensible in operant conditioning" (p. 168). An acquaintance of his, the author Arthur Koestler, visited the Reed College lab at Oceanic Institute one afternoon. I explained that we were interested in the capacity of fish to discriminate shapes and colors, and began to show him the operant equipment and explain the procedures. His face suddenly froze, and he ejaculated, "Oh—Classical conditioning!" turned abruptly, and strode from the lab without another word. Bateson also had no interest in our operant conditioning endeavors. Pryor's success in attracting and holding the attention of Bateson, Koestler, Lorenz, and many other intellectuals and research scientists suggests a special reason for behavior analysts to be interested in her work.

As illustrated by the vignette just above, the "operant approach" to behavior has often been greeted with hostility and described in distorted caricatures. Behavior analysts have addressed these problems by identifying the distortions that appear in standard textbooks (Todd & Morris, 1983); by direct rebuttals to attacks and mischaracterizations (e.g., Catania's, 1991, reply to Mahoney; MacCorquodale's, 1970, reply to Chomsky); by questioning whether we should relax our adherence to technical language (e.g., Branch, 1977; Deitz, 1986; Hineline, 1984; Shimp, 1976), perhaps even adopting a stance of humility when interacting with people of other viewpoints (Neuringer, 1991); and by examining the characteristics of our language that may make it especially threatening or susceptible to distortion (Hineline, 1980, 1990). In contrast, Pryor has been notably successful at engaging the interest of people who are unacquainted with or even hostile to the explicit use of the techniques of operant conditioning. Thus, as an additional approach to this problem, her prose bears examining for clues regarding how to write effectively about behavioral work when addressing general audiences.

[3] What Skinner specifically rejected from ethological explanations were mental activities as explanations, when behavior was not yet explainable by contingencies, phylogenic or ontogenic. He also questioned the concepts of inner states and relations between them, and dynamic analogies or metaphors in discussing drives, because the functional relations they attempt to formulate are not clearly understood (see Skinner, 1966).

Figures of Speech, or Conceptual Confusion?

What comes across most obviously, is an engaging, casual prose style. The initial reactions of regular *JEAB* readers may be to decry much of this as introducing "explanatory fictions," and to advise that we examine such phrasing carefully to see whether any essential characteristics of behavior analysis have been lost in achieving broadly accessible prose. Some of the casual phrasing is comprised of figures of speech that clearly are not to be taken literally by anyone, and it may communicate more accurately, as well as more engagingly, to the nonspecialist reader. For example, an astronomer is not understood as reverting to pre-Copernican science when referring to observations made at sunrise, rather than to observations under conditions in which the angle of incidence between the observer's position and the sun is tangent to the surface of the earth. Pryor's statement that I noted earlier, "if you can't tell when your animal is thinking hard, you'll never make it" (p. 111), might be considered similarly. "Thinking hard" is a phrase occasioned by situations in which repertoires are evolving and are maintained by potent establishing conditions. With the vernacular phrase, Pryor is saying, partly, that one must be able to discriminate satiation effects from extinction effects, and partly that effective control of behavior in transition is not always evidenced by vigorous overt activity. The statement would lose its punch if one tried to explain it in these ways to a general audience.

There do seem to be some conceptual inconsistencies in Pryor's account, however, particularly in her use of anthropomorphic phrasing that implies awareness, countered by repeated assertions that speculating about inner states of an animal can handicap the trainer. Thus, on one hand, she tells of a porpoise who routinely jumped into an adjoining tank where another porpoise was kept, doing this only after the trainers had left for the day. Pryor says that "the animals knew (their behavior) was illegal and made their moves clandestinely, when there were no people in sight" (p. 216). The relevant discriminative stimulus is easily specified as the absence of people, so the incident could have been characterized readily in behavioral terms, but instead she attributes the behavior to the animals' knowledge. On the other hand, Pryor describes the advice she gave to her women trainers who were sometimes too willing "to let an animal get away with sloppy work." "Don't sympathize with the animal, don't try to imagine what it is thinking—you cannot possibly KNOW what it is thinking, so you can't use that as a basis for detection. Stop feeling sorry for the porpoise. Stick to the training rules" (pp. 112–113).

In related fashion, Pryor often identifies operant conditioning with consciousness and classical conditioning with unconsciousness (p. 11). Yet she recognized early on that her trainers often developed bad training procedures unconsciously, such as cueing behavior only at regular intervals or in particular locations. She also emphasizes the fact that operant conditioning of humans sometimes occurs despite the person's unawareness of the discriminative stimulus or of the operant being reinforced. For example, in training the trainers at Sea Life Park, Pryor used a "Training Game" that she had adapted from a visiting psychologist. As part of the weekly, voluntary meeting for trainers, one person (the future trainee) was sent out of the room; the rest decided on a chain of behavior to be shaped, and someone was chosen to be the trainer. The trainee was called back to the room, and while the group looked on, the trainer began the shaping of that action, using only a whistle to reinforce approximations to the specified action. This was "a quick and cheap way of drumming training laws into the novice's head. . . . We learned that it was possible for an animal, even a human, to show a response correctly without having any understanding of what it was supposed to be doing. . . . It was interesting, too, to see who made a good subject and who did not. Brains, at least introspective intellectualizing brains, were not of much use to the person playing the animal" (pp. 121–123). She describes how one man's behavior was shaped without his awareness, although he engaged repeatedly in the fist clenching that was the specified behavior, and another case in which a discriminative stimulus (kazoo blowing) effectively cued the behavior of hand clapping without the subject's ever becoming aware of the signal. In this passage, Pryor sounds like a confirmed radical behaviorist. It is interesting that when she seems less so, it usually is when discussing nonhuman behavior.

Although Pryor seems oblivious to some conceptual implications of informal phrasing, she is very concerned with the practical rather than the conceptual implications of particular ways of talking. It may be more complicated than this, however: My memories of the many discussions I had with Karen during the period covered by this book are now dimmed. However, my impression was that during that time she was somewhat ambivalent toward behavior analysis. She seemed disinterested in theoretical questions; she was all for action, getting a job done, showing results, and success.

The Art and Science of Training

Pryor's explicitly conceptual discussions focus mostly on "the borderline between the art and the science of training" (p. 278), a theme that emerges repeatedly. There seem to be two variants of this theme; Pryor couches one of these in terms of the trainer's awareness of training and the ability to follow explicit rules (i.e., scientific principles) when training, in contrast with more intuitive training. The other seems to concern the reciprocity between the behavior of trainer and trainee. The interplay between these two themes is only partly captured by the phrase, "operant shaping."

Awareness versus Unaware, or Rule Governed versus Contingency Shaped

To some degree, Pryor identifies the two approaches to training with two distinct communities of people:

> I became conscious of the existence of two vast camps of trainers: the psychologists, with their elegant . . . rules for training, but no rules for . . . the hunches, the timing, the intuitive outguessing of the animal; and the practical animal trainers, with vast individual experience but with their own superstitious behaviors, people who usually were unable to sort the useful from the merely traditional in their shaping recipes, and who had a tendency to explain far too much on the basis of the personalities of the animals and the magnetic personality of the trainer himself. Two vast camps, and almost no communication between them. (p. 214)

The artistic dimension can also apply to the work of trainers who strive to incorporate behavioral scientific principles into their work. Here, the contrast between the art and the science of training concerns "the differences between what the skilled operant conditioner knows and what the practical animal trainer knows: between the science of training and the art of training . . . things like knowing when to quit and thinking up shaping recipes and choosing a good subject" (p. 123). An example she gives is from a session of the Training Game, when a skilled trainer was attempting to train a man to sit on a table. The subject's approaches to the table were readily shaped, as well as the response of leaning against it, but the subject emitted no tentative "sitting" movements. The trainer then quickly changed his approach, shaped walking backwards, eventually into a wastebasket that tripped the subject so that he sat upon the table.

This, then, she characterizes as the art of training. It seems to be most salient in the individual differences between trainer performances, "the hunches, timing, the intuitive outguessing of the animal" (p. 124). Alternatively, one might view it as identifying the contingency-shaped aspects of training, with the trainers' individual differences originating in their unique histories. As contingency-shaped behavior, the self-descriptions that constitute awareness, and the describing and following of explicit rules, are peripheral, if not irrelevant, to what is going on.

Pryor repeatedly indicates that the scientific method is the best way she has discovered to improve her own training performances. She appreciated the helpful advice of Ron Turner in solving particular training problems: "[his] simple rule . . . to look, when things went wrong, at what you were actually reinforcing, bailed me out of a lot of problems" (p. 113). A cumulative recorder was a very valuable adjunct in training, revealing problems of timing, training slips that had gone undetected, and chains of behavior sequences that the trainers hadn't identified. That is, the recorder not only revealed errors but also showed complex behavioral patterns of which all of the trainers were unaware. Impressed by these findings, Pryor had a helper record her own vocal cues and reinforcements during a project in shaping pony behavior, in which she had been having little success. She discovered that her vocal reinforcements were often late, that she was ignoring some correct pony behavior, and that sometimes she gave two commands at once. After an analysis of this objective recording, she was able to train her pony in a matter of minutes, so improved was her training performance. She endorses the event re-

corder as a great time-saver and potentially a splendid source of new information when training subjects. One might conclude that as the science of training develops and its technology is adopted, the art of training is left an increasingly smaller area of operation.

There is, however, lurking an odd blind spot, as we have just seen. Pryor holds that part of the "art" of training is sensitivity to "timing," stating that the psychologist doesn't provide rules about it; yet she reports the dramatic improvement in her own timing performance in pony training when a cumulative recorder provided the necessary objective facts. She clearly recognized that other trainers often require similar information from the "science" of training because their intuitive "timing" is simply off the mark. This shifting between two aspects of training is similar to shifts between rule-governed and contingency-shaped behavior in other domains. For example, similar shifts between contingency-shaped and rule-governed behavior are readily identified in the domains of athletic and musical performance.

Reciprocity Between Trainer and Trainee

Pryor identifies a second domain of questions concerning the science versus the art of training that concern the reciprocity between trainer and trainee.

> Why does the animal love the trainer? At what point, and why, does the artificial communication system of operant conditioning begin to give way to some genuine social communication, to that feeling that trainers call rapport? It is a golden feeling when the trainer really begins to feel as if he IS reading the animal's mind, or when the animal begins to respond to the trainer's voice and emotions. . . . It is really an eerie thrill when the animal turns the training system around and uses it to communicate with you. (p. 124)

In this discussion, Pryor seems to wander beyond both her Lorenzian and her Skinnerian roots. From the latter viewpoint, which is familiar to most of this journal's readers, an account in terms of love, rapport, or eerie thrill is inadequate if we are unable to analyze those terms functionally. To be sure, the shaping situation is a social one from its inception, because the trainer is engaged in an intrinsically social relationship with the subject as soon as there is a discernible effect on the behavior of the subject. Still, many social communication systems exist in nature for which we do not use the term "rapport"—the dance of the honeybee in the presence of its hive sisters is one example of such genuine social communication. We identify such arguments with Skinner's position; they also suggest the position that Lorenz (1991) expressed in his last book, where he indicated a way of coming to terms with the situations that typically occasion such questioning. Lorenz believed that the behavior of animals can be investigated objectively, but that their subjective experience is inaccessible. The traditional behaviorist approach of declining the attempt to study that experience seems reasonable to him.

> For a thinker who accepts evolution, the evidence of subjectivity in both his fellow human beings and the higher animals is undeniable. . . . Nevertheless, such recognition should not mislead us into thinking that we can fathom or replicate the subjective states of animals. Our feelings are simply an indicator of convergent adaptation. Similarities point to important research goals which may be only indirectly accessible: to know the conditions that govern our emotional responses as well as the relationships between animals. (p. 262)

The penultimate paragraph in Lorenz's book concludes:

> We do not deny that we are thrilled when an old, familiar greylag goose returns after a lengthy absence. The reality that we are investigating is the interaction between ourselves and the environment, between intuition and objective knowledge. . . . What we should not forget is that we cannot know, and probably will never know, what the goose itself feels. We can assume that similar processes take place in humans and animals. Because these analogous structures concern us as knowledge-seeking human beings, we should regard it as a duty to investigate these processes as far as we can take them with the only means at our disposal, the scientific method. (pp. 263–264)

Thus, Lorenz would contend that social communication between humans and porpoises will never extend to experiencing true rapport.

Lengthy exposure to a subject does enable one to detect or selectively respond to those bodily cues that are reliably linked with its emotional or deprivation states—and the subject may learn similar things about the trainer. This can occur in an operant conditioning lab, an oceanarium, a primate study center, or at

home with one's family. D. O. Hebb (Hebb & Thompson, 1954) demonstrated many years ago that chimpanzees can engage in a variety of repertoires that are aptly (and even usefully) characterized in terms such as deception and teasing, jealousy, friendliness, anger, and chronic malice. The trained observer can identify aggression, mock-aggression, and friendliness with high reliability, and can measure them by carefully counting behavior frequencies and noting the temporal ordering of behavior chains. Hebb found that the number of reported attacks on keepers by the chimpanzees provided an independent and highly correlated measure of chimpanzee social repertoires as measured in these ways. This pioneering study began to transform portions of the "art" into the "science" of animal handling, amplifying hunches, intuitions, or eerie feelings into teachable rules or procedures that could be applied to other animals, keepers, and settings.

Pryor holds that it would be a mistake to conclude that porpoises "have an abstract language or are in any way more than nice bright animals. Two-way communication, however: that, through training, we built. Communing might be a better word" (p. 125). She provides illustrative events: A porpoise refused to leave its home tank when cued to do so, for it had a piece of wire stuck in its teeth. "Misbehavior"[4] was sending a message to the trainer; after the wire was detected and removed, the animal responded as cued. ("Communing" seems to me a distinctly inappropriate term for classifying this particular act of communication. It seems to be a term descriptive of the emotional response of the trainer to a certain type of event, and does not apply to the type of event itself.) Another instance, also reported in one of her scientific papers, was of a porpoise stroking the trainer gently and repeatedly with a fin during a very good training session, a gesture very frequent between porpoises but extremely rare from porpoise to human, and interpreted by Pryor as signaling affection (p. 127). Pryor gives no examples of explicitly built communicative repertoires.

On the other hand, the fact that trainers must allow their behavior to be controlled in certain explicit ways by their subjects is something that Pryor illustrates repeatedly. Pryor found that male trainers had greater difficulty than women in this respect: Men, she found, "tended to feel that when the animal didn't respond correctly it was defying him. Then the man got mad . . . a self-created ego battle with an animal. . . . If women, in general, had a drawback as trainers, it was their kind hearts" (p. 112). The trainer must identify promptly those movements that approximate the desired behavior when they occur, reinforce immediately, and select only ever-closer approximations to the goal behavior. This attentiveness to the subject must come under control of the subject's relevant behavior; the excellent trainer must ignore many other sources of stimulation, internal and external. I believe that many college instructors, as well as parents, never do let enough of their own behavior come under sufficient subject control to be optimally effective, especially during the initial stages of shaping.

Animals can also control and mistrain the trainer effectively, Pryor warns. It is tempting to leave a signal on just a little longer when a dilatory animal seems about to emit the appropriate behavior, but this can result in a trainer leaving the signal on longer and longer until the performance is out of control. To me, it seems that in such instances the trainer's "hunches" or "intuitive outguessing" of the animal have proven to be deficient—the trainer needs to follow the training rules instead. There is an engaging account of how a porpoise sought to control the behavior of Pryor, who was training the animal to accept suction cups over its eyes in order to blind it temporarily during a demonstration of the animal's sonar ability. A spontaneous porpoise behavior—sinking slowly and without movements towards the bottom—came to be cued by any attempt to place the suction cups. Pryor cleverly brought this behavior under a sound-cue control given under water, reinforcing the animal's staying down longer and longer, as long as the sound cue continued, for up to 30 s. She then incorporated this sinking into the public performances of the porpoise and wove a plausible

[4]This term has a different meaning from that used by Breland and Breland (1961) in their well-known paper on misbehavior. Pryor was discussing an animal's refusal to respond to performance cues under the appropriate environmental conditions, rather than the intrusion into a trained performance of phylogenic behavior elements.

story line into the narrative for the audience, attributing the sinking and inactivity to "hurt pride." The audience could not hear the underwater cue being provided to the porpoise, of course. The problem behavior of sinking to avoid having suction cups placed over the eyes disappeared when it was put on cue, without further trainer action. Putting behavior under stimulus control simultaneously reduces its occurrence in the absence of the signal, she notes. "You do NOT have full control over the behavior just because you can order it up when you want it; you must also make sure it is no longer offered spontaneously when you did NOT ask for it" (p. 47).

Some of Pryor's procedures were forced on her by circumstances: For example, training more than one porpoise at a time was often unavoidable, and she discusses some of the attendant difficulties. It is much more difficult to identify the desired behavior in such situations, and to provide immediate reinforcement to one subject without interrupting the behavior of another. (Most readers of *JEAB* can recall how Skinner's style of research was strongly affected by his wartime applied work with pigeons under special circumstances.) She observed her subjects carefully, and was quick to recognize and adapt already-occurring behavior into her shows by selective reinforcement and the introduction of appropriate discriminative stimuli, both visual and auditory. Pryor's account of her career provides many examples of her ability to transform "art" into "science" of training, for humans as well as for a variety of other species.

Spontaneity or Novelty; Variability and Mimicry

"The Creative Porpoise" chapter provides an account of a widely publicized experiment conducted by Pryor and her chief trainer and reported in *JEAB* in 1969. This article reviewed wide attention from psychologists, and modified accounts appeared in several popular magazines. The study was actually initiated by a porpoise that, while waiting for a cue from the trainer during a regular show, started emitting a completely novel form of response. Pryor recognized what was occurring, and gave reinforcers then and thereafter only on the occasion of behavior patterns that the porpoise had never performed in earlier sessions. In subsequent shows, the animal continued to generate novel behavior patterns, some of which Pryor states she would never have imagined and would have found very difficult to shape. Some novel patterns were ones she had observed in other animals of the same species; others had been observed in other porpoise species only, whereas a few were utterly novel. It was Gregory Bateson who wisely urged Pryor to replicate this creativity in a second animal, and to keep full records for a scientific report. Another porpoise was studied for 30 sessions, resulting in complete success.

> The change in "personality," from a docile, inactive animal to an active, observant animal full of initiative was a permanent change. . . . It was a useful change, too. . . . Navy trainers developed a technique . . . of both refreshing an animal and extending its awareness and sophistication by having "playtimes" between or after more stringent training sessions, in which all kinds of things could be reinforced, and from which, sometimes, came new and useful responses. (p. 247)

To my knowledge, the observations about the permanent change in "personality" have not been followed up; they surely deserve attention.

Writing the scientific report about the creative porpoise was a challenge for Pryor. It took hundreds of hours to complete the documentation of the "nuggets of truth" contained in her research. Her first draft was returned from *JEAB,* "with 10 pages of single-spaced criticisms and suggested corrections" for "ambiguities and anthropomorphisms and other details" (p. 248) that the editors identified. "Another result for me was that my admiration for other researchers was most powerfully reinforced. . . . (it was) the hardest single task I'd ever undertaken" (p. 249).

Pryor also recorded a remarkable event that illustrates observational learning in two porpoises who performed separately, one at a time, but could see one another during their acts. One had come to the park when a juvenile; as she grew, she came increasingly to resemble the other, older porpoise. On a particular day, both animals seemed unusually nervous during the performance; there were minor difficulties with some of the repertoires, but neither Pryor nor her chief trainer realized what was going on until after the show. The wrong member of the pair had been admitted first

into the show tank, and had been required to go through the other animal's routine, as the trainer had confused each with the other. The second member of the pair was then confronted with the same challenge, and succeeded. Clearly, during the months in which these two animals performed in close proximity to one another, each had acquired the capability to take over the other's role successfully with no explicit training in the other's role.

When visiting Sea Life Park, Lorenz said to Pryor, " 'Conscious mimicry of something not in the animal's natural repertoire is extremely sophisticated—it is an example of . . . higher-order learning. Naturally, you are not going to see this spontaneously, at least not often.' Bravo, and also aha" (p. 172). (How does one classify mimicry as conscious or not? Or to what extent does learning alter the innate movements involved in mimicry?) There is considerable evidence that imitation of another's response occurs spontaneously even in juvenile birds, as my colleague Allen Neuringer's early research with both young and adult pigeons "following the feeder" demonstrated some years ago (Bullock & Neuringer, 1977; Neuringer & Neuringer, 1974). Lorenz might well argue that no new response is involved in Neuringer's research; what is learned is where the innate response of pecking will provide reinforcers, or the characteristics that identify reinforcers for pecking. From such classic research as that of Kuo (1938), we learned that complex hunting and eating strategies are acquired much more frequently by cats which in infancy lived with a mother that hunts, kills, and eats prey. Studies such as those of Kuo, Neuringer, and Pryor may well be on a continuum, differing with regard to the complexity of the sequences, the time required, and the topography of behavior acquired through mimicry.

Educating the Public

What can slip by the reader who has never seen the shows at Sea Life Park is Pryor's skill at shaping human behavior, through the riveting shows she designed and scripted. When the Sea Life Park shows first began, they were a novel educational undertaking as well as enjoyable spectacles. In the Science Theater, the large audience, chiefly tourists, was shown not merely the range of skills possessed by porpoises but also the possibility of complex cetacean–human interactions, undoubtedly giving many onlookers their first direct experience with the complexity of cetacean behavior, the mammalian and peculiarly cetacean characteristics of porpoises, and some relevant research findings and undertakings. The nature of operant conditioning was also demonstrated and discussed in these performances, as these themes were interwoven into the Science Theater shows in a unique way, providing an educational experience for many. Pryor believed that "What made the show interesting was the information we crammed in and around (the porpoises') activities. . . . What was usually on display was our own enthusiasm, curiosity, interest, and fund of information" (p. 104). Thousands of people have been exposed to these exciting, informative, and probably attitude-altering displays each day over a period of many years. Clearly, Pryor exemplifies the master teacher, in her specially designed theater-classroom, with a large audience eagerly following each detail as she recounts the past training history of an animal, describes the stages at which it is in her projected program, and then illustrates continuing training with a high degree of success.

For someone wanting to learn trainer skills, Pryor intertwines anecdotes with operant training principles in a way that any novice trainer should find very useful, in her chapter on shaping. The problem of changing the setting in which the shaped behavior is to occur, with as little disruption of the performance as possible, is one that Pryor recognized and learned to handle. There are numerous observations about the differences between species and individuals, beginning with their behavior in the open ocean, in early captivity, in training, and in long-term captivity, that give the reader unusual perspective on the trainer's problems.

In sum, this book is interesting, thought-provoking, and valuable to those concerned in shaping animal behavior inside and outside the laboratory. It is also an excellent supplement to more conventional textbooks, adding themes of ethology and comparative psychology to our consideration of behavior as primary focus of study. Viewed as applied research, Pryor's work is clearly related to more recent reports of such investigators as Baum (1989), Pepperberg, Brese, and Harris (1991), and Timberlake (1990), who are doing experiments in

more naturalistic or richer environments than is characteristic of the traditional laboratory. Karen Pryor's research and her development of complex repertoires in cetaceans and other animals are impressive accomplishments, enriching our understanding of the "science and art" of teaching and of the maintenance of complex repertoires.

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